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Viva Naughton Reservoir, Lincoln County, Wyoming

National Eutrophication Survey, Corvallis, Oreg

Prepared for

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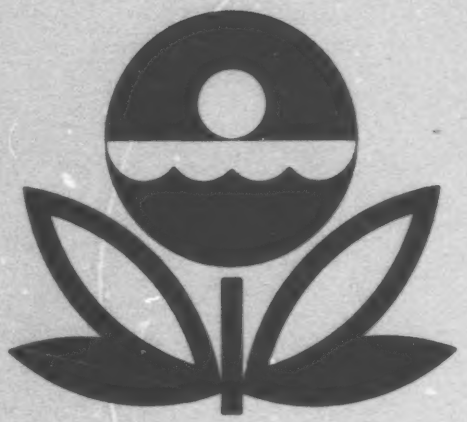
U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY

WORKING PAPER SERIES



REPORT
ON
VIVA NAUGHTON RESERVOIR
LINCOLN COUNTY
WYOMING
EPA REGION VIII
WORKING PAPER No. 892

CORVALLIS ENVIRONMENTAL RESEARCH LABORATORY - CORVALLIS, OREGON
and
ENVIRONMENTAL MONITORING & SUPPORT LABORATORY - LAS VEGAS, NEVADA

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REPORT
ON
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EPA REGION VIII
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WITH THE COOPERATION OF THE
WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY
AND THE
WYOMING NATIONAL GUARD
AUGUST, 1977

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16. ABSTRACT

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to freshwater lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's freshwater lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Wyoming Department of Environmental Quality for professional involvement, to the Wyoming National Guard for conducting the tributary sampling phase of the Survey, and to those Wyoming wastewater treatment plant operators who voluntarily provided effluent samples.

The staff of the Water Quality Division provided invaluable lake documentation and counsel during the Survey, reviewed the preliminary reports, and provided critiques most useful in the preparation of this Working Paper series.

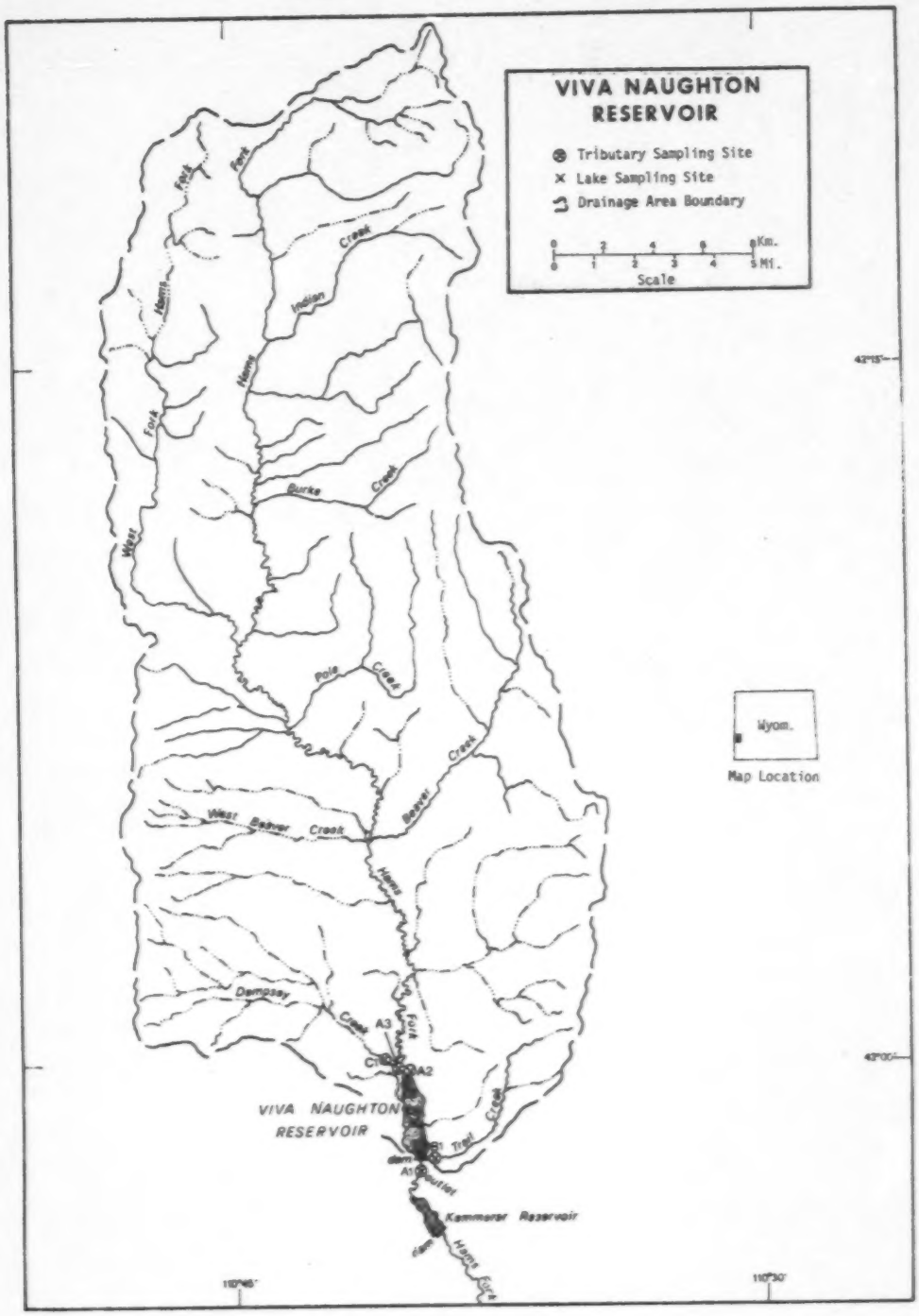
Brigadier General James L. Spence, The Adjutant General of Wyoming, and Project Officer Colonel Donald L. Boyer, who directed the volunteer efforts of the Wyoming National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY RESERVOIRS

State of Wyoming

NAME	COUNTY
Big Sandy	Sublette, Sweetwater
Boulder	Sublette
Boysen	Fremont
De Smet	Johnson
Flaming Gorge	Sweetwater, WY; Daggett, UT
Fremont	Sublette
Glendo	Converse, Platte
Keyhole	Crook
Ocean	Fremont
Seminoe	Carbon
Soda	Sublette
Viva Naughton	Lincoln
Woodruff Narrows	Uinta
Yellowtail	Bighorn, WY; Bighorn, Carbon, MT


VIVA NAUGHTON RESERVOIR
Tributary Sampling Site
Lake Sampling Site
Drainage Area Boundary
Scale
Km.
Mi.
Wyom.
Map Location
North Fork
Indian Creek
Horse Creek
West Fork
Burke Creek
Pole Creek
Beaver Creek
West Beaver Creek
Dempsey Creek
A3
A2
A1
VIVA NAUGHTON RESERVOIR
Trail Creek
Kemmerer Reservoir
42°15'
43°00'
110°45'
110°30'

VIVA NAUGHTON RESERVOIR

STORET NO. 5612

I. CONCLUSIONS

A. Trophic Condition:

Survey data indicate that Viva Naughton Reservoir is eutrophic. It ranked thirteenth in overall trophic quality among the 14 Wyoming lakes and reservoirs sampled in 1975 when compared using a combination of six water quality parameters*. Eleven of the water bodies had less median total phosphorus, all of the others had less median dissolved orthophosphorus and mean chlorophyll a, eight had less median inorganic nitrogen, and six had greater mean Secchi disc transparency. Marked depression of dissolved oxygen with depth occurred at station 2 in August.

Survey limnologists noted algal blooms in progress each of the three sampling times, and massive summer blue-green algae blooms in this reservoir have been reported (Gaufin, 1963).

B. Rate-Limiting Nutrient:

The algal assay results are not considered representative of conditions in the reservoir at the times the samples were taken (08/06/75 and 10/16/75) due to significant changes in the nutrients in the samples during shipment from the field to the laboratory.

The reservoir data indicate nitrogen limitation at all sampling times.

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*See Appendix A.

C. Nutrient Controllability:

1. Point sources--No known municipal or industrial wastewater facilities impacted Viva Naughton Reservoir during the sampling year. Septic tanks serving shoreline residences were estimated to have contributed 0.3% of the total phosphorus load, but a shoreline survey would have to be conducted to determine the significance of those sources.

The present phosphorus loading of 0.67 g/m^2/year is more than that proposed by Vollenweider (Vollenweider and Dillon, 1974) as an oligotrophic loading but less than his suggested eutrophic loading (see page 12). However, there was an apparent loss of phosphorus during the sampling year, (i.e., more phosphorus was measured leaving the outlet than entering via the inlets), and the calculated loading probably is too low. This may be indicative of unmeasured nutrient input from non-point source runoff, an underestimation of septic tanks loads, or the resolubilization of previously sedimented phosphorus within the reservoir. Whatever the cause, it is likely that the loading reported above is less than the actual phosphorus load the reservoir receives.

2. Non-point sources--Non-point sources accounted for 99.7% of the total phosphorus load during the sampling year. Hams Fork contributed 87.4%, and Trail Creek contributed 3.7%. The ungaged minor tributaries and immediate drainage contributed an estimated 5.9%

Any improvement in the present trophic condition of the

reservoir would likely be dependent on non-point source control. Much of the surrounding area is pasture and rangeland, and further investigation is needed to determine the nutrient contribution and controllability of such sources.

II. RESERVOIR AND DRAINAGE BASIN CHARACTERISTICS†

A. Morphometry††:

1. Surface area: 5.90 kilometers^2.
2. Mean depth: 8.9 meters.
3. Maximum depth: 22.9 meters.
4. Volume: 52.510 x 10^6 m^3.
5. Mean hydraulic retention time: 170 days (based on outflow).

B. Tributary and Outlet:
(See Appendix C for flow data)

1. Tributaries -

Name	Drainage area (km^2)*	Mean flow (m^3/sec)*
Hams Fork (A-2)	530.9	3.780
Hams Fork (A-3)	0.0	0.033
Trail Creek	7.5	0.055
Minor tributaries & immediate drainage -	79.9	0.055
Totals	618.3	3.923

2. Outlet -

Hams Fork	624.2**	3.570

C. Precipitation***:

1. Year of sampling: 24.6 centimeters.
2. Mean annual: 24.7 centimeters.

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† Table of metric conversions--Appendix B.
†† Neuchwander, 1976.
* For limits of accuracy, see Working Paper No. 175, "...Survey Methods, 1973-1976".
** Includes area of reservoir.
*** See Working Paper No. 175.

III. WATER QUALITY SUMMARY

Viva Naughton Reservoir was sampled three times during the open-water season of 1975 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from a number of depths at three stations on the reservoir (see map, page v). During each visit, a single depth-integrated (4.6 m or near bottom to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the August and October visits, a single 18.9-liter depth-integrated sample was composited for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll a analysis. The maximum depths sampled were 5.8 meters at station 1, 15.5 meters at station 2, and 18.0 meters at station 3.

The sampling results are presented in full in Appendix D and are summarized in the following table.

A. SUMMARY OF PHYSICAL AND CHEMICAL CHARACTERISTICS FOR VIVA NAUGHTON RESERVOIR
STORET CODE 5612

PARAMETER	1ST SAMPLING (8/ 6/75) 3 SITES RANGE	MEAN	MEDIAN	2ND SAMPLING (9/18/75) 3 SITES RANGE	MEAN	MEDIAN	3RD SAMPLING (10/16/75) 3 SITES RANGE	MEAN	MEDIAN
TEMP (C)	13.0 - 19.0	17.6	18.5	10.4 - 11.3	11.0	11.0	8.9 - 9.4	9.2	9.2
DISS OXY (MG/L)	1.8 - 9.0	7.8	8.3	6.2 - 8.0	7.1	7.3	7.4 - 8.0	7.8	7.8
CNDCTVY (MCROMO)	233. - 251.	245.	245.	205. - 244.	236.	241.	207. - 224.	211.	210.
PH (STAND UNITS)	8.2 - 9.3	9.0	9.1	8.0 - 8.8	8.6	8.7	8.3 - 8.4	8.4	8.4
TOT ALK (MG/L)	141. - 152.	147.	148.	138. - 150.	146.	147.	137. - 146.	140.	140.
TOT P (MG/L)	0.022 - 0.247	0.059	0.033	0.081 - 0.175	0.107	0.095	0.047 - 0.100	0.061	0.056
ORTHO P (MG/L)	0.005 - 0.113	0.025	0.013	0.027 - 0.044	0.033	0.029	0.023 - 0.027	0.024	0.024
NO2+NO3 (MG/L)	0.020 - 0.030	0.021	0.020	0.020 - 0.020	0.020	0.020	0.040 - 0.050	0.041	0.040
AMMONIA (MG/L)	0.020 - 0.210	0.050	0.030	0.060 - 0.140	0.100	0.090	0.080 - 0.100	0.094	0.095
KJEL N (MG/L)	0.200 - 0.500	0.329	0.300	0.400 - 0.800	0.558	0.600	0.400 - 0.700	0.458	0.400
INORG N (MG/L)	0.040 - 0.240	0.071	0.050	0.080 - 0.160	0.120	0.110	0.120 - 0.140	0.135	0.140
TOTAL N (MG/L)	0.220 - 0.520	0.350	0.320	0.420 - 0.820	0.578	0.620	0.440 - 0.740	0.499	0.440
CHLRPYL A (UG/L)	14.0 - 21.4	18.6	20.5	6.0 - 87.8	34.0	8.2	4.9 - 39.0	22.6	23.8
SECCHI (METERS)	1.8 - 2.1	1.9	1.8	0.5 - 1.5	1.2	1.5	1.5 - 2.7	2.2	2.4

B. Biological Characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal Units per ml
08/06/75	1. Aphanizomenon sp.	4,430
	2. Chroomonas (?) sp.	292
	3. Microcystis sp.	243
	Other genera	390
	Total	5,355
09/18/75	1. Aphanizomenon sp.	4,073
	2. Schroederia sp.	41
	Total	4,114
10/16/75	1. Aphanizomenon sp.	2,135
	2. Cryptomonas sp.	137
	3. Chroomonas (?) sp.	172
	4. Stephanodiscus sp.	34
	Total	2,478

2. Chlorophyll a -

Sampling Date	Station Number	Chlorophyll a (µg/l)
08/05-06/75	1	14.0
	2	21.4
	3	20.5
09/18/75	1	8.2
	2	6.0
	3	87.8
10/16/75	1	4.9
	2	23.8
	3	39.0

C. Limiting Nutrient Study:

Due to significant changes in the nutrients in the samples during shipment from the field to the laboratory, the assay

results are not considered representative of conditions in the reservoir at the times the samples were taken (08/05-06/75 and 10/16/75).

The reservoir data indicate nitrogen limitation at all sampling stations and times; i.e., the mean inorganic nitrogen/orthophosphorus ratios were 8/1 or less, and nitrogen limitation would be expected.

IV. NUTRIENT LOADINGS
(See Appendix E for data)

For the determination of nutrient loadings, the Wyoming National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page v). Sampling was begun in October, 1974, and was completed in September, 1975.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Wyoming District Office of the U.S. Geological Survey for the tributary sites nearest the reservoir.

In this report, nutrient loads for sampled tributaries were calculated using mean annual concentrations and mean annual flows. Nutrient loads for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated using the mean concentrations in Trail Creek at station B-1 and the mean annual ZZ flow (nutrient loads for Hams Fork at station A-3 are included in the minor tributary loads).

No known municipal or industrial point sources impacted the reservoir during the sampling year.

A. Waste Sources:

1. Known municipal - None

2. Known industrial - None

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	kg P/yr	% of total
a. Tributaries (non-point load) -		
Hams Fork	3,455	87.4
Trail Creek	145	3.7
b. Minor tributaries & immediate drainage (non-point load) -	235	5.9
c. Known municipal STP's - None	-	-
d. Septic tanks* -	10	0.3
e. Known industrial - None	-	-
f. Direct precipitation** -	105	2.7
Total	3,950	100.0

2. Outputs -

Reservoir outlet - Hams Fork 5,290

3. Net annual P loss - 1340 kg.

* Estimate based on 30 lakeshore dwellings; see Working Paper No. 175.
** See Working Paper No. 175.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	kg N/yr	% of total
a. Tributaries (non-point load) -		
Hams Fork	111,575	88.6
Trail Creek	2,945	2.3
b. Minor tributaries & immediate drainage (non-point load) -	4,715	3.7
c. Known municpal STP's - None	-	-
d. Septic tanks* -	320	0.3
e. Known industrial - None	-	-
f. Direct precipitation** -	6,730	5.1
Total	125,925	100.1

2. Outputs -

Reservoir outlet - Hams Fork -19,115

3. Net annual N accumulation - 6,810 kg.

D. Non-point Nutrient Export by Subdrainage Area:

Tributary	kg P/km^2/yr	kg N/km^2/yr
Hams Fork	7	210
Trail Creek	19	393

* Estimate based on 30 lakeshore dwellings; see Working Paper No. 175.
** See Working Paper No. 175.

E. Yearly Loads:

In the following table, the existing phosphorus loadings are compared to those proposed by Vollenweider (Vollenweider and Dillon, 1974). Essentially, his "dangerous" loading is one at which the receiving water would become eutrophic or remain eutrophic; his "permissible" loading is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic loading would be considered one between "dangerous" and "permissible".

Note that Vollenweider's model may not be applicable to water bodies with short hydraulic retention times.

	Total Phosphorus		Total Nitrogen	
	Total	Accumulated	Total	Accumulated
grams/m^2/yr	0.67	loss*	21.3	1.2

Vollenweider phosphorus loadings ($g/m^2/yr$) based on mean depth and mean hydraulic retention time of Viva Naughton Reservoir:

"Dangerous" (eutrophic loading)	0.84
"Permissible" (oligotrophic loading)	0.42

* There was an apparent loss of phosphorus during the sampling year. This may have been due to solubilization of previously sedimented phosphorus, recharge with phosphorus-rich ground water, unknown and unsampled point sources, or underestimation of septic tank loads.

V. LITERATURE REVIEWED

Gaufin, Arden R., 1963. Limnological survey of Lake Viva Naughton and Kemmerer Reservoir, Wyoming. Prelim. Rept. to Utah Power and Light Co., U. of Utah, Salt Lake City.

Neuchwander, Ken, 1976. Personal communication (reservoir morphometry). Utah Power and Light Co., Salt Lake City.

Vollenweider, R. A., and P. J. Dillon, 1974. The application of the phosphorus loading concept to eutrophication research. Natl. Res. Council of Canada Publ. No. 13690, Canada Centre for Inland Waters, Burlington, Ontario.

VI. APPENDICES

APPENDIX A

LAKE RANKINGS

LAKE DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P
5601	BIG SANDY RESERVOIR	0.087	0.060	487.667	4.383	8.800	0.020
5602	BOULDER LAKE	0.008	0.040	361.800	2.483	8.400	0.002
5603	BOYSEN RESERVOIR	0.037	0.140	465.923	6.264	14.400	0.014
5604	LAKE DE SMET	0.033	0.040	409.000	11.167	9.400	0.006
5605	FLAMING GORGE RESERVOIR	0.014	0.605	366.461	5.611	12.200	0.003
5606	FREMONT LAKE	0.006	0.040	-22.000	3.783	7.400	0.002
5607	GLENDO RESERVOIR	0.045	0.315	459.182	8.473	12.600	0.014
5608	KEY HOLE RESERVOIR	0.028	0.050	454.583	7.792	14.000	0.004
5609	OCEAN LAKE	0.043	0.040	478.333	7.500	8.600	0.004
5610	SEMINOLE RESERVOIR	0.030	0.130	447.000	2.536	11.000	0.007
5611	SODA LAKE	0.063	0.040	387.500	5.575	15.000	0.014
5612	VIVA NAUGHTON RESERVOIR	0.065	0.120	430.000	25.067	13.200	0.024
5613	WOODRUFF NARROWS RESERVO	0.069	0.105	470.000	12.950	13.200	0.019
5614	YELLOWTAIL RESERVOIR	0.026	0.310	364.500	5.410	10.000	0.017

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P	INDEX NO
5601	BIG SANDY RESERVOIR	0 (0)	54 (7)	0 (0)	77 (10)	77 (10)	8 (1)	216
5602	BOULDER LAKE	92 (12)	92 (11)	92 (12)	100 (13)	92 (12)	92 (12)	560
5603	BOYSEN RESERVOIR	46 (6)	23 (3)	23 (3)	46 (6)	8 (1)	42 (5)	188
5604	LAKE DE SMET	54 (7)	73 (9)	62 (8)	15 (2)	69 (9)	62 (8)	335
5605	FLAMING GORGE RESERVOIR	85 (11)	0 (0)	77 (10)	54 (7)	46 (6)	85 (11)	347
5606	FREMONT LAKE	100 (13)	73 (9)	100 (13)	85 (11)	100 (13)	100 (13)	558
5607	GLENDO RESERVOIR	31 (4)	8 (1)	31 (4)	23 (3)	38 (5)	42 (5)	173
5608	KEY HOLE RESERVOIR	69 (9)	62 (8)	38 (5)	31 (4)	15 (2)	69 (9)	284
5609	OCEAN LAKE	38 (5)	92 (11)	8 (1)	38 (5)	85 (11)	77 (10)	338
5610	SEMINOLE RESERVOIR	62 (8)	31 (4)	46 (6)	92 (12)	54 (7)	54 (7)	339
5611	SODA LAKE	23 (3)	92 (11)	69 (9)	62 (8)	0 (0)	31 (4)	277
5612	VIVA NAUGHTON RESERVOIR	15 (2)	38 (5)	54 (7)	0 (0)	27 (3)	0 (0)	134
5613	WOODRUFF NARROWS RESERVO	8 (1)	46 (6)	15 (2)	8 (1)	27 (3)	15 (2)	119
5614	YELLOWTAIL RESERVOIR	77 (10)	15 (2)	85 (11)	69 (9)	62 (8)	23 (3)	331

LAKES RANKED BY INDEX NOS.

RANK	LAKE CODE	LAKE NAME	INDEX NO
1	5602	BOULDER LAKE	560
2	5606	FREMONT LAKE	558
3	5605	FLAMING GORGE RESERVOIR	347
4	5610	SEMINOLE RESERVOIR	339
5	5609	OCEAN LAKE	338
6	5604	LAKE DE SMET	335
7	5614	YELLOWTAIL RESERVOIR	331
8	5608	KEY HOLE RESERVOIR	284
9	5611	SODA LAKE	277
10	5601	BIG SANDY RESERVOIR	216
11	5603	BOYSEN RESERVOIR	188
12	5607	GLENDO RESERVOIR	173
13	5612	VIVA NAUGHTON RESERVOIR	134
14	5613	WOODRUFF NARROWS RESERVO	119

APPENDIX B

CONVERSION FACTORS

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107×10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX C

TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR WYOMING 08/05/76

LAKE CODE 5612 LAKE VIVA NAUGHTON

TOTAL DRAINAGE AREA OF LAKE(SQ KM) 624.2

TRIBUTARY	SUB-DRAINAGE AREA(SQ KM)	NORMALIZED FLOWS(CMS) JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
5612A1	624.2	0.82	0.82	0.99	5.86	16.20	11.92	2.38	0.82	0.62	0.71	0.82	0.82	3.57
5612A2	530.9	0.59	0.71	0.88	6.37	16.03	13.03	3.28	1.36	1.13	0.68	0.62	0.59	3.78
5612A3	0.0	0.0	0.0	0.028	0.057	0.142	0.057	0.057	0.057	0.0	0.0	0.0	0.0	0.033
5612B1	7.5	0.028	0.028	0.028	0.057	0.227	0.057	0.057	0.057	0.028	0.028	0.028	0.028	0.055
5612ZZ	85.5	0.0	0.0	0.028	0.142	0.283	0.142	0.057	0.0	0.0	0.0	0.0	0.0	0.055

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 624.2
SUM OF SUB-DRAINAGE AREAS = 623.9
TOTAL FLOW IN = 46.98
TOTAL FLOW OUT = 42.79

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
5612A1	10	74	0.906	6	1.274				
	11	74	0.850						
	12	74	1.019	8	1.048				
	1	75	0.991						
	2	75	0.963						
	3	75	1.076	3	1.019				
	4	75	1.359	30	5.550				
	5	75	14.045						
	6	75	19.907						
	7	75	9.968	14	10.449				
	8	75	2.520						
	9	75	1.614	29	1.529				
5612A2	10	74	0.850	6	0.566				
	11	74	0.708	22	0.566				
	12	74	0.566	8	0.425				
	1	75	0.566						
	2	75	0.708						
	3	75	0.708	3	0.850				
	4	75	1.133	30	1.133				
	5	75	13.592						
	6	75	19.539						
	7	75	9.628						
	8	75	1.982						
	9	75	0.850	29	0.623				

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LAKE CODE 5612 LAKE VIVA NAUGHTON

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
5612A3	10	74	0.0						
	11	74	0.0						
	12	74	0.0						
	1	75	0.0						
	2	75	0.0						
	3	75	0.028						
	4	75	0.057						
	5	75	0.142						
	6	75	0.057						
	7	75	0.057						
	8	75	0.057						
	9	75	0.0						
561281	10	74	0.028	6	0.028				
	11	74	0.028	22	0.028				
	12	74	0.028	8	0.028				
	1	75	0.028						
	2	75	0.028						
	3	75	0.028						
	4	75	0.085						
	5	75	0.170						
	6	75	0.057						
	7	75	0.057	14	0.057				
	8	75	0.057						
	9	75	0.028	29	0.028				
5612ZZ	10	74	0.0						
	11	74	0.0						
	12	74	0.0						
	1	75	0.0						
	2	75	0.0						
	3	75	0.028						
	4	75	0.142						
	5	75	0.283						
	6	75	0.142						
	7	75	0.057						
	8	75	0.0						
	9	75	0.0						

APPENDIX D

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 76/08/05

561201
42 00 15.0 110 39 48.0 3
VIVA NAUGHTON RESERVOIR
56023 WYOMING

11EPALES 2111202
0023 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
75/08/06	14 15	0000	19.0	8.8	72	245	9.20	151	0.020	0.300	0.020K	0.012
	14 15	0005	18.9	9.0		245	9.20	151	0.020K	0.300	0.020K	0.005
	14 15	0019	18.6	8.6		251	9.10	152	0.040	0.400	0.020K	0.014
75/09/18	12 40	0000	10.7	6.4	60	244	8.50	150	0.130	0.400	0.020K	0.044
	12 40	0005	10.6	6.2		244	8.00	150	0.130	0.600	0.020	0.044
	12 40	0015	10.4	6.4		205	8.60	150	0.140	0.500	0.020K	0.042
75/10/16	13 00	0000	8.9	7.4	60	224	8.35	138	0.080	0.400	0.040	0.023
	13 00	0005	8.9	7.6		208	8.30	137	0.100	0.400	0.040	0.024
	13 00	0012	8.9	7.4		207	8.30	137	0.100	0.400	0.040	0.024

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
75/08/06	14 15	0000	0.022	14.0	
	14 15	0005	0.041		
	14 15	0019	0.026		
75/09/18	12 40	0000	0.085	8.2	
	12 40	0005	0.090		
	12 40	0015	0.081		
75/10/16	13 00	0000	0.049	4.9	
	13 00	0005	0.048		
	13 00	0012	0.050		

K VALUE KNOWN TO BE
LESS THAN INDICATED

24

STORET RETRIEVAL DATE 76/08/05

561202
41 59 12.0 110 40 00.0 3
VIVA NAUGHTON RESERVOIR
56023 WYOMING

11EPALES 2111202
0054 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
75/08/06	14 35	0000	19.0	8.2	84	251	9.10	150	0.040	0.500	0.020K	0.013
	14 35	0005	19.0	8.6		249	9.15	152	0.020	0.300	0.020K	0.013
	14 35	0015	18.9	8.6		249	9.10	141	0.040	0.400	0.020	0.016
	14 35	0030	18.1	7.6		247	8.95	145	0.030	0.300	0.020K	0.014
	14 35	0050	13.3	1.8		235	8.20	150	0.210	0.400	0.030	0.113
75/09/18	13 05	0000	11.0	7.6	60	240	8.70	150	0.070	0.600	0.020K	0.029
	13 05	0005	11.3	7.2		241	8.70	138	0.080	0.800	0.020	0.032
	13 05	0019	11.2	7.6		239	8.70	141	0.090	0.400	0.020K	0.032
	13 05	0051	10.8	7.4		211	8.75	142	0.060	0.600	0.020K	0.027
75/10/16	12 45	0000	9.4	8.0	96	210	8.35	140	0.100	0.500	0.040	0.024
	12 45	0005	9.4	7.8		210	8.40	141	0.100	0.500	0.040	0.025
	12 45	0015	9.2	8.0		211	8.35	140	0.100	0.400	0.040	0.024
	12 45	0043	9.0	8.0		208	8.40	138	0.100	0.400	0.040	0.023

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
75/08/06	14 35	0000	0.247	21.4	
	14 35	0005	0.045		
	14 35	0015	0.029		
	14 35	0030	0.026		
	14 35	0050	0.144		
75/09/18	13 05	0000	0.086	6.0	
	13 05	0005	0.098		
	13 05	0019	0.095		
	13 05	0051	0.087		
75/10/16	12 45	0000	0.067	23.8	
	12 45	0005	0.064		
	12 45	0015	0.066		
	12 45	0043	0.047		

K VALUE KNOWN TO BE
LESS THAN INDICATED

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STORET RETRIEVAL DATE 76/08/05

561203
41 56 10.0 110 39 35.0 3
VIVA NAUGHTON RESERVOIR
56023 WYOMING

11EPALES 2111202
0063 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
75/08/05	15 00	0000	18.5	8.6	72	245	9.15	143	0.030	0.300	0.020K	0.017
	15 00	0005	18.5	8.2		243	9.20	145	0.030	0.300	0.020K	0.013
	15 00	0015	18.4	8.4		243	9.10	144	0.040	0.300	0.020K	0.013
	15 00	0025	18.3	8.2		249	8.30	144	0.030	0.200	0.020K	0.020
	15 00	0040	15.0	5.9		243		151	0.120	0.200	0.030	0.074
	15 00	0059	13.0	8.2		233	9.25	145	0.030	0.400	0.020K	0.013
75/09/18	13 25	0000	11.3	8.0	18	240	8.80	146		0.800	0.020K	0.030
	13 25	0005	11.3	7.4		242	8.80	145		0.600	0.020K	0.028
	13 25	0015	11.2	7.4		242	8.75	148		0.400	0.020K	0.027
	13 25	0030	11.1	7.2		241	8.70	146		0.400	0.020K	0.028
	13 25	0059	10.9	6.8		242	8.80	147		0.600	0.020K	0.028
75/10/16	12 20	0000	9.4	8.0	108	210	8.40	146	0.090	0.700	0.040	0.027
	12 20	0005	9.3	7.8		220	8.40	141	0.090	0.600	0.040	0.026
	12 20	0015	9.3	8.0		210	8.40	142	0.090	0.400	0.040	0.024
	12 20	0035	9.2	7.6		208	8.40	138	0.090	0.400	0.050	0.023
	12 20	0056	9.2	7.6		210	8.40	141	0.090	0.400	0.040	0.025

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
75/08/05	15 00	0000	0.034	20.5	
	15 00	0005	0.033		
	15 00	0015	0.027		
	15 00	0025	0.029		
	15 00	0040	0.081		
	15 00	0059	0.047		
75/09/18	13 25	0000	0.175	87.8	
	13 25	0005	0.145		
	13 25	0015	0.104		
	13 25	0030	0.096		
	13 25	0059	0.137		
75/10/16	12 20	0000	0.081	39.0	
	12 20	0005	0.100		
	12 20	0015	0.060		
	12 20	0035	0.051		
	12 20	0056	0.053		

K VALUE KNOWN TO BE
LESS THAN INDICATED

APPENDIX E

TRIBUTARY AND WASTEWATER TREATMENT PLANT DATA

STORET RETRIEVAL DATE 76/08/05

561241
41 57 51.0 110 39 35.0 4
HAMS FORK
56 15 KEMMERER
O/LAKE VIVA NAUGHTON 110692
BELOW VIVA NAUGHTON DAM
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/10/06	11 50		0.008	1.000	0.025	0.015	0.042
74/11/22	12 05		0.008	1.300	0.045	0.005	0.030
74/12/08	10 22		0.024	0.500	0.045	0.010	0.020
75/03/03			0.125	0.400	0.065	0.030	0.050
75/04/30	10 15		0.170	1.150	0.265	0.025	0.040
75/07/14	17 30		0.020	1.250	0.065	0.035	0.040
75/09/29	17 00		1.150	0.300	0.005K	0.085	0.110

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/08/05

561281
41 57 55.0 110 39 15.0 4
TRAIL CREEK
56 15 KEMMERER
T/LAKE VIVA NAUGHTON 110692
DIRT ROAD .1 MI E OF VIVA NAUGHTON DAM
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/10/06	10 00		0.016	1.400	0.020	0.045	0.075
74/11/22	11 00		0.008	0.900	0.025	0.035	0.050
74/12/08	10 15		0.056	0.600	0.010	0.030	0.060
75/07/14	17 00		0.015	1.400	0.165	0.075	0.110
75/09/29	17 34		3.300	0.800	0.010	0.035	0.130

STORET RETRIEVAL DATE 76/08/05

5612A2
42 00 50.0 110 40 05.0 4
HAMS FORK
56 7.5 WILKINSON CK
T/LAKE VIVA NAUGHTON 110691
DIRT RD BRDG 15 MI NW OF KEMMERER
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/10/06	12	18	0.008	0.500	0.010	0.005	0.015
74/11/22	12	30	0.008	1.100	0.020	0.010	0.010
74/12/08	10	00	0.008	0.300	0.010	0.010	0.010
75/03/03	10	00	0.125	1.050	0.300	0.035	0.040
75/04/30	09	30	0.170	1.000	0.180	0.020	0.040
75/09/29	17	00	1.150	0.200	0.005K	0.005K	0.060

K VALUE KNOWN TO BE
LESS THAN INDICATED